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Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JANUARY to SEPTEMBER, 1917.

THE conditions prevailing have rendered it necessary that "KNOWLEDGE" should be published less frequently during the War, and there has been considerable delay in bringing out the present number, for which we crave the indulgence of our readers. In future "KNOWLEDGE" will be published on a definite day, and the next number will appear on November 25th, 1917. It is not a time to make more changes than are necessary, but it is hoped that everyone interested in "KNOWLEDGE" will make any suggestions for the improvement of the Magazine. All the help that can be given is needed, and the General Editors take the opportunity of thanking their colleagues the column editors and other regular contributors for giving their services gratuitously until the end of the War. Gratitude is also due to many new subscribers, who have come forward to support the Magazine, and to the scientific societies, who have ordered a number of copies for that express purpose.

* * * *

ON another page we publish the results of an investigation by MM. Albert and Alexandre Mary of some of the experimental work of Dr. Bastian, whose results are confirmed in a striking manner.

Considering the importance of the subject to biologists and bacteriologists, it is strange that no systematic attempts have been made to explain the meaning of the observed facts.

Living micro-organisms are found in tubes which have been heated to temperatures far beyond those which have long been recognised as sufficient to produce sterility.

The results are too constant, and the precautions taken are too rigid, to admit of the possibility of accidental contamination from the air having taken place in whole series of experiments, and the only other alternatives are, either that living matter has been produced *de novo* in sterile tubes, or that living micro-organisms can be protected by colloidal silica in such a way that they or their spores can resist a temperature far above that which destroys them under ordinary conditions, and can then subsequently develop at the ordinary temperature.

This latter alternative could probably be determined experimentally by exposing cultivations of different kinds of bacteria to temperatures of 130° to 140° C. in the presence of colloidal silica.

In any case the matter ought not to be allowed to rest here. When Buchner first published the account of his experiments, in which he claimed to have produced alcoholic fermentation without the aid of living yeast cells, a committee of English chemists was appointed to investigate the truth of the matter, and they speedily confirmed his results.

When Sir William Ramsay claimed to have effected the transmutation of elements by the application of radium emanation, his work was repeated by a host of other chemists, but with negative results. To quote the latest publication on the subject by Mr. F. Soddy,* the recent results confirm the view previously taken, "that these gases (helium or neon) are not obtained when due precautions against contamination are taken."

When Dr. Bastian, in 1910, offered an account of his recent work to the Royal Society, it was declined as being "unsuitable for publication." It is the experimental part of this work which is now confirmed by MM. Mary, who conclude that the facts themselves are indisputable, whatever the interpretation of them may be.

* * * *

ALTHOUGH the British Association did not hold its usual Annual Meeting, the Conference of Delegates of Corresponding Societies met in London on July 5th and 6th. Mr. John Hopkinson, the President, gave a most excellent address on "The Work and Aims of our Corresponding Societies." It is not, he said, to stimulate and direct scientific investigation only that the Conference should aim; there is also for it the wider field of influencing public opinion on the importance of far greater attention than is at present being given to scientific education and to many problems concerned with the future welfare

* *Annual Reports on the Progress of Chemistry* for 1916, p. 271.

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of our nation in which Science may lend a fostering hand. There is no other country in the world which has nearly so many Scientific Societies as we have. There are on our list one hundred and twenty Corresponding Societies (ninety Affiliated and thirty Associated), with an aggregate membership exceeding forty-six thousand, subject to a slight reduction, as some of these Societies are represented individually as well as by the Union to which they belong, and some have members who are also members of other Societies on our list; but we may, he thought, estimate the number of individual members represented as not fewer than forty-five thousand.

It was perhaps when speaking of Economic Science and Statistics that Mr. Hopkinson touched on one of the most important points to be considered at the present day. He urged that many matters which came into the sphere of party politics ought never to have been treated as such. Under this heading was Free Trade. Kent's Cavern and the necessity for its protection came in for consideration under Anthropology. Museums were dealt with as a part of education; and of Agriculture Mr. Hopkinson had a good deal to say.

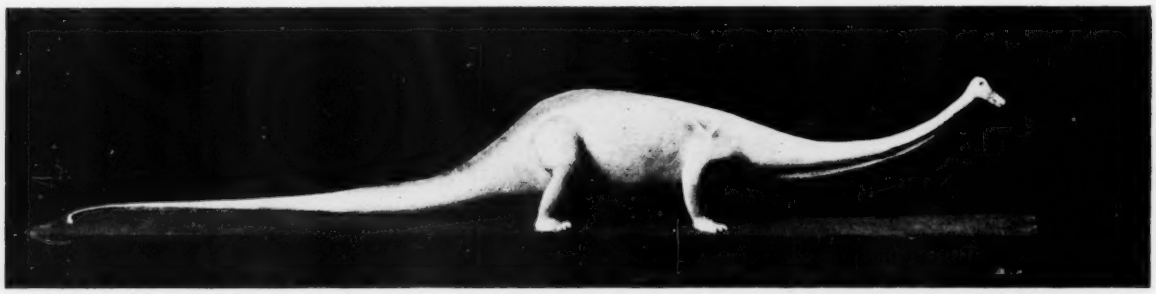

FIGURE 1.—Plaster cast of a Model of a reconstructed Dinosaurian Reptile (*Diplodocus carnegeii*), made by the Rev. H. Neville Hutchinson, M.A., F.G.S., F.Z.S., based on the reconstructed skeleton now in the Natural History Museum, South Kensington. Length about eighty-one feet, height over twelve feet. It is thought by many naturalists that the limbs should be spread out sideways, as in living reptiles, instead of being upright. This view has been expressed in the above model. Mr. Hutchinson will shortly publish a paper on the subject in *The Geological Magazine*.

Mr. Hopkinson took in turn the various Sciences which are dealt with in the sections of the British Association, and considered them from the point of view of the Corresponding Societies. Under the heading of Zoölogy he dealt with the preservation of our native fauna, claiming that in the endeavour to prevent the destruction of rare animals, or of those approaching extinction, all may help. We cannot well make sure of the presence of a rare moth or butterfly without capturing it, but there is never need to take large series, as is the practice of some entomologists. With birds and mammals it is different. They can mostly be identified by the practised naturalist without shooting them. There are birds, such as the rook and the wood-pigeon, which should be reduced in number, as they are so destructive to our field and garden crops; but such birds as hawks and owls, which are persecuted by gamekeepers, are our farmers' best friends, and their extermination ought not be to allowed. The same may be said of all insectivorous birds.

He urged that we must no longer look down upon our farmers. One consequence of our present fiscal system is that the social status of our workers is now generally in an ascending scale from producers, through manufacturers, to merchants, being in relation to the amount of money each class makes; but we must reverse this, even to the extent of placing our tenant farmers on a social level with professional men, such as doctors. The medical profession, rightly, stands high—doctors look after our health—but we are depending upon farmers for our life.

The special subjects discussed at the Conference were "Regional Surveys," introduced by Mr. C. C. Fagg; "Weights and Measures," in connection with which Mr. Thomas Sheppard read a paper; and "The Part to be Played by Local Societies after the War in the Application of Science to the Needs of the Country," in which case the discussion was opened by the Secretary, Mr. Wilfred Mark Webb.

FLORA SELBORNIENSIS.

ON several previous occasions we have published pages in facsimile from "The Nature Calendar," which Gilbert White kept in the year 1766, under the title of "Flora Selborniensis." He had already in the previous year endeavoured to turn his "Garden Kalendar" into a nature diary, but had lapsed into his old style, and the present notes were kept quite separately from the garden entries. The pages, which deal with the time when flowers were plentiful, speak for themselves. The fact that when Gilbert White went to Fyfield, on June 16th, to see his brother he kept up his observations—probably taking his manuscript with him—is worthy of notice.

32. June 10. Yellow succory, or rough hawk-weed, Hieracium asperum, majore flore, in agrorum limitibus, flowers.
Virginian spiderwort, Ephemeron, in flower.
H. Viper's bugloss, echium vulgare, blows.
Hairy impatient Ladysmock, Cardamine impatiens hirsutior, in seed: the seed vessels split, & curl up on the least touch.
Meadow pinks, wild Willians, or Cuckow flower, Lychnis plumaria sylvestris simplex, blows.
Yellow water flower-de-luce, Iris palustris pallida, in blossom.
Water-elder, Opulus Ruellii, flowers.
St Peter's wort, Hypericum ascyron dictum, caule quadrangulo, shews the radiments of bloom.
Mithridate-mustard, or bastard cress, Thlaspi vulgatius, in seed.
Treacle-mustard, or penny cress, Thlaspi Dioscoridis, going out of bloom.
Male speedwell, or fluellin, veronica mas supina, & vulgatissima, blows. Tota est hirsuta, folio rotundiore. This is supposed to possess the greatest virtues of any speedwell.
Dier's weed, or wood-waxen, Genistella tinctoria, begins to flower.

33.

June 12. Tare everlasting, common yellow bastard-vetchling, Lathyrus luteus sylvestris dumetorum, blows.
Garden Chervil, cerefolium sativum, blows.
Scorzonera angustifolia subcaerulea, flowers.
Salsafie, tragopogon purpureum, in bloom.
Bush-vetch, vicia sepium perennis, in pod.
Rasp-berry-bush, Rubus Idaus spinosus, blows.
Alpine Geranium blows.
Garden-pink flowers.
Garden red valerian. Valeriana floribus rubris caudatis, in bloom.
13. Provence rose blows.
Sweet Williams flower.
Kidney-vetch, or Ladies finger, vulneraria rustica, in bloom.
Butterfly-orchis, orchis alba bifolia minor calcari oblongo, in flower.
Romagna melon blows.
Cantaleupe melon, melo cortice tuberosus, blows.
Briony black, Tamnus, blows.
Garden-parsnep, pastinaca sativa, in flower.
Spurrey, alsine spergula dicta major, buds for bloom.

34. June 14. Sage, salvia, flowers.
Strawberries begin to redden.
Cherries begin to change colour.
Narrow-leaved, branched, clammy Catch-fly, Lychnis angustifolia, viscosa, ramosa, sive nascipilla vulg: flowers.
Female handed-orchis, or female Satyrion Royal. Orchis palmata speciosiore thryso, folio maculato, in Bloom
Field-Scabious, Scabiosa major, blows.
Upright tormentil, tormentilla erecta, flowers.
Bladder-campion, or white corn-campion, Lychnis sylvestris, beta alburn vulgo, blows.
Long-rooted Hawkweed, Hieracium longius radicatum, begins to flower.
Great bur-reed, sparganium ramosum, flowers.
Great vernal Cyperus-grass, gramen Cyperoides cum paniculis nigris, blows.
The glow-worm appears.
Wheat ears begin to peep
15. Small wild mallow, or dwarf mallow, Malva sylvestris folio rotundo, blows.
The wild briar, dog's rose, or hep tree, rosa sylvestris inodora, seu canina, blooms.
Thistles begin to blow.

35

June 15. The bramble, or black-berry bush, Rubus fructa nigro, blows.
Great purple monk's-hood, Aconitum purpureum maximum, blowing.
Mulberry tree, Morus, blows.
Myrtle-leaved sumach, coriaria, blows.
Jerusalem sage, Phlomis, in flower.
Shrubby cinque-foil, potentilla, blows.

Fyfield.

June 16. St foin is cutting every where.
Great wild Valerian, valeriana sylvestris major, blowing.
Common English wild Clary, Horminum sylvestre, Lavendula flore, blows in vast plenty.
Nep, or cat-mint, Nepeta major, not yet blown.
Burnet-leaved rose, rosa spinosissima, blows.
17. Cross-wort, or mugweed, Cruciata hirsuta, sive, Gallium latifolium, flowers.
Yellow toad's flax, linaria lutea, blows.
Great knapweed, or matfellon, Jacea major, blows.
Water scorpion-grass, myosotis scorpioides palustris, blossoms.
Long-leaved water-speedwell, or brook-lime, veronica aquatica longifolia.

THE EXPERIMENTAL WORK OF DR. BASTIAN ON THE ORIGIN OF LIFE.

By ALBERT and ALEXANDRE MARY.

(*Translated from the French.*)

FOR many years before his death Dr. H. Charlton Bastian, F.R.S., claimed that his experimental work pointed to the synthesis of particular forms of living matter in a colloidal medium, silica, to which had been added various saline substances. Prior to his discussions with us, Dr. Bastian had made use of only two forms of silicate preparations, which, from their colour, he termed "white solution" and "yellow solution." In view of the great importance of the problem, we have studied his experiments closely for some years, and have thought it advisable to verify some of his work. For this purpose we have used two forms of his "white solution."

In February, 1913, we introduced into sixty tubes the following mixture:—

Distilled water	360 c.c.
Sodium silicate solution ...	60 drops
Dilute phosphoric acid	180 drops
Ammonium phosphate ...	12 grammes

Eight other tubes were charged with a mixture of forty cubic centimetres of colloidal silica diluted with a filtered saline solution composed of—

Distilled water	114 c.c.
Ammonium phosphate	3 grammes
Dilute phosphoric acid	2 c.c.

All the tubes were sealed immediately over a Bunsen flame, and were then heated for twenty minutes in an autoclave at 140° C. Yet, when incubated for two months at 20° to 27° C., they yielded a very light flocculent deposit, which contained monococci, diplococci, streptococci, staphylococci, and bacilli, which could be stained readily with aniline dyestuffs. They did not grow in ordinary bouillon, nor on agar, but when cultivated in a special bouillon (*bouillon de mamelle*) they produced a general turbidity in three or four days, whilst they formed a sedimentary growth in a 0·5 per cent. solution of iron lactate, with or without the addition of dextrose

Hence there could be no doubt as to the existence of organisms in solutions which bacteriologists would have had no hesitation in asserting to be sterile, in view of the treatment to which they had been subjected. The results of these experiments were published in *Le Médecin* (Brussels), October 31st, 1913.

Our personal experience inclined us to believe that the method of working which we have described would permit of the development *de novo* of living organisms in many other mineral solutions, provided that they contained colloids. Between June 26th and July 3rd, 1913, we distributed the following solutions in four series of tubes:—

(1) Distilled water, potassium ferrocyanide, ferrous sulphate.
(2) Distilled water, a citro-ammoniacal solution of iron pyro-phosphate, sodium silicate.
(3) Distilled water, calcium chloride, sodium silicate.
(4) Distilled water, potassium ferrocyanide, ferrous sulphate, sodium silicate.

In each case thirty cubic centimetres of freshly distilled water were used, with a few drops of ten per cent. solutions of the respective salts.

After being charged, the tubes were sealed in a Bunsen flame and sterilised for ten minutes in an autoclave at 130° C.

These new experiments were also successful, and the results were published in detail in *Le Médecin* (Brussels), January 15th, 1914. But not all the tubes were opened at that time, some being reserved for further examination. These were only opened on March 30th, 31st, and April 1st, 1915, after standing for more than a year and a half. They then contained a slight flocculent deposit, which, when treated by Unna's method, yielded the most interesting organised forms.

In the four types of solution, examined under a magnification of one thousand eight hundred diameters, we established the constant presence of a micrococcus, which could be deeply stained, in a bed of *micellae* which resisted the staining reägents. This microörganism often assumed the form of a diplococcus; more rarely that of *Streptococcus brevis*. The particular organisms in each type of solution showed the following distinctive characteristics:—

SOLUTION I.—This contained an abundant deposit of *micellae*:* cocci and diplococci of a deep violet colour; well-developed torulae of a deep violet or rose colour, forming a well-defined pellicle and showing a granular structure. They formed small groups, produced buds, and emitted hyphae. Lastly, there was an abundant formation of branched, tufted, delicate mycelia, with spore-

* Nägeli's term for large colloid molecules (see *Origin of Life*, by H. Charlton Bastian, M.D., F.R.S., published by Watson & Co.)

XUM

bearing or club-shaped ends, and of a deep violet colour.

SOLUTION II.—This contained no torulae, but an abundant deposit of mycelia of a deep violet colour, bearing few tufts and producing no spores. The bacteria had a close resemblance in their characteristics, and especially in their colour, to fragments of mycelia.

SOLUTION III.—This contained no torulae, but slightly tufted mycelia and large curved bacilli with refractive capsules. There were also large zoögloeal masses of finely granular structure and of a deep blue colour and small zoögloeal deposits, which when treated by Unna's method became pink.

SOLUTION IV.—This contained the same mycelia, together with small colonies of a special bacterium, of considerable size, slightly curved, and with rounded ends. It was stained blue by Unna's method.

All the organisms mentioned above are, without exception, composed of aggregates of cocci. They can be cultivated, especially in their initial undefined micellar form, in a solution of iron lactate (0·5 per cent.), with or without the addition of dextrose, or in a mixture of dilute solutions of sodium phosphate and ammonium tartrate. Another suitable culture medium consists of: Distilled water, 100 c.c.; tyrosin, 0·135 gramme; and ammonium tartrate, 3 grammes.

Cultivations of Solutions I and IV were made in the usual way in this medium on April 1st, 1915. By April 19th an appreciable bluish-green sediment had formed in tubes containing Solution I, whilst a pronounced turbidity, with an abundant flocculent deposit, had been produced in tubes containing Solution IV. These flocculent deposits occupied the lower part of the tubes to a height of several centimetres, and were depressed above, so as to form a very concave, coalescent, and but slightly mobile surface. Examined under the microscope the cultivations from I were seen to consist of cocci and torulae. In the cultivations from IV we noticed an abundant growth of the bacillus mentioned above, which is not stained by Gram's method, together with numerous cocci, well-developed *Streptococci breves*, and masses of torulae, with widely branching hyphae, which budded vigorously.

Our experiments of July 13th were afterwards repeated, in part, by Dr. Bastian, who obtained analogous results, which he included in his paper, published in *Nature* (December 24th, 1914), under the title, "The Production at Will of either Fungus Germs, Flagellate Monads, or Amoebae from the Ultimate Segments of Small Masses of Zoögloea."

Our success in extending the experiments of Dr. Bastian affords a powerful confirmation of the truth of the facts observed by him, however surprising they may appear. Theories are subject to continual modification; but every experimental result, which has been verified under varying conditions, is a definite gain for science, apart from all theoretical considerations; and in future no one will be able to investigate the problems of the origin of life without recognising the importance of Dr. Bastian's work.

We feel sure that before long France, though somewhat late in the day, will appreciate the value of that striking work. The French translation of "The Nature and Origin of Living Matter," to which A. Pratelle has given several years of work, will shortly be published, and will be discussed and meet with the same recognition as was the first French translation of Darwin's great work.

CORRESPONDENCE.

"THE PROPER ASPECT OF SPONTANEOUS GENERATION."

To the Editors of "KNOWLEDGE."

SIRS,—An interesting communication from Mr. H. Onslow, of Cambridge, in *Nature* of February 22nd gives the results of some experiments similar to those of the late Dr. Bastian, but with negative results.

It should be read by those who are following the discussion on spontaneous generation in recent days.

Using, as Bastian did, diffused daylight, Mr. Onslow has failed to obtain evidence that, under the conditions of Bastian's experiments, life in the scientific sense is spontaneously produced.

They have not, however, used instead of sunlight any other kind of radiation, such as radio-activity: and obviously if radiation be the stimulant required to start the vital process through some unknown type of chemical or catalytic action, one or other of the various radiations from radium should have been tried.

The experiments are no doubt expensive, but they are supremely important, and therefore well worthy of being prosecuted, although they may involve bankruptcy to private individuals unless aided by State grants.

I suggested more than once to Dr. Bastian that under suitable conditions the radio-active radiations, some of which are of the nature of light, *i.e.*, the γ rays, would be more advantageous than sunlight, particularly if the source of energy were actually embedded in the nutritive soil.

My experiments in this direction are well known, and I have still many culture-tubes, which were sterilised at Cambridge more than ten years ago, containing radium as described in my earlier work (see *Nature*, May 25th, 1905).

These tubes are examined externally from time to time, and the microscopic study of their contents will prove an interesting and perhaps important matter, even should they turn out to be mere physical effects, such as Butschli's and Leduc's, and some of those I have already described, which received much attention at the time.

It is upon lines such as these, however, as I venture to think, that the problem should be tackled. For the prob-

ability is that, if spontaneous generation did take place in the remote past, and there can be little doubt that it did, the process was a slow one—probably extremely slow indeed—the circumstances being also most assuredly unusual. Further, that the first bodies so produced were not in all respects like the living organisms of to-day may safely be asserted, even if they should have possessed some of the qualities which we now associate with living matter.

Bacteria, as we know them, are no doubt the products of a long line of evolutionary antecedents, in which natural selection must have played an important and at times a

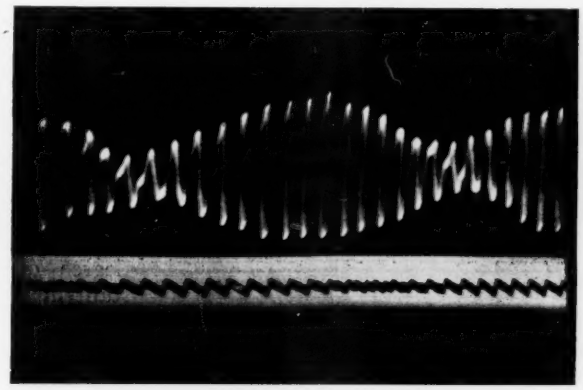

FIGURE 1.

rapidly changing part. But the problem is one, I maintain, for the physicist rather than the biologist—paradoxical as this may seem—since the properties of matter, from which, presumably, life evolved, *i.e.*, atoms, electrons, and ether, of the internal qualities of which we still know very little, are physical. I trust, therefore, that the biologist will once more pardon this intrusion into what he has hitherto regarded, and perhaps only too jealously though not unreasonably, as his own proper sphere of speculation and research.

It should be borne in mind that Pasteur and Tyndall were both physicists, and it would have been of interest to know what Stokes and FitzGerald might have thought of these methods of studying the question were they amongst us to-day, in view of the remarkable discoveries of Rutherford, on the radio-active changes which certain forms of matter undergo, and the amazing changes in the electrical properties of all matter at very low temperatures, recently found by Ohnes.

What kind of chemical action the evolution of animate from inanimate matter implies still remains to be ascertained. But the study of the inmost recesses of the atom, like those of the ether itself, remains a promised land to the investigator of the future; and there is little doubt but that it is upon the physicist that the burden will fall, if matter is ever to divulge the secret.

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ON THE "WOLF-NOTE" OF THE VIOLIN AND 'CELLO.

To the Editors of "KNOWLEDGE."

SIRS,—It has long been known that on all musical instruments of the violin family there is a particular note which is difficult to excite in a satisfactory manner, and that when this "wolf-note," as it is called, is sounded, the whole body of the instrument vibrates in an unusual degree, and it seems to have been understood that the difficulty of eliciting a smooth note of this particular pitch is due in some way to the sympathetic resonance of the instrument.* In a recent paper,† G. W. White has published some experimental work confirming this view. The most striking effect noticed is the *cyclical* variation in the intensity of the tone obtained when the instrument is forced to speak at this point. White suggests as an explanation of these fluctuations of intensity that they are due to the beats which accompany the forced vibration imposed on the resonator. The correctness of this suggestion seems open to serious criticism. For, the beats which are produced when a periodic force acts on a vibrator are essentially *transitory* in character, whereas in the present case the fluctuations in intensity are *persistent*. The following explanation of the effect which is different from that suggested by White occurred to me some time ago on theoretical grounds, and has since been confirmed by me experimentally. The effect depends on the fact (which is itself a consequence of theory) that, when the pressure with which the bow is applied is less than a certain critical value proportionate to the rate of dissipation of energy from the string, the principal mode of vibration of the latter in which the fundamental is dominant is incapable of being maintained, and passes over into one in which the octave is prominent. When the bow sets the string in vibration, the instrument is strongly excited by sympathetic resonance, and the rate of dissipation of energy rapidly increases, and continues to increase beyond the limit up to which the bow can maintain the string in the normal mode of vibration. The form of vibration of the string then alters into one in which the fundamental is feeble compared with the octave. Following this, the amplitude of vibration of the belly decreases, but this change lags behind that of the string to a considerable extent. When the rate of dissipation of energy again falls below the critical limit, the string begins to regain its original form of vibration with the dominant fundamental.

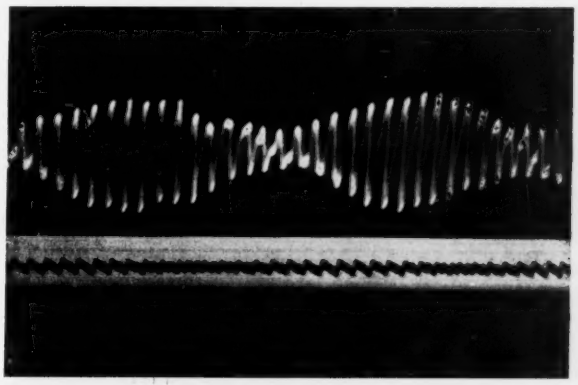

FIGURE 2.

This is accordingly followed, after an interval, by a fresh increase in the vibration of the belly, and the cycle then repeats itself indefinitely.

Figures 1 and 2, showing the simultaneous vibration-curves of the belly (above) and the string (below) of a "'cello," amply confirm the foregoing explanation suggested by theory, and are themselves of interest. It will be seen that the changes in the vibrational form of the string are about quarter of a cycle in advance of those of the belly, and that in both curves the octave is conspicuous when the amplitude is a minimum.

C. V. RAMAN.

THE INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE,
CALCUTTA

* Guillemin, *The Application of Physical Forces*, 1877.

† *Proc. Camb. Phil. Soc.*, June, 1915.

WEATHER FORECASTING.

By Captain D. Wilson-Barker, R.D., R.N.R.

(With Illustrations from photographs by the Writer.)

Sailors, fishermen, shepherds, and others whose lives are spent for the most part in the open are often intuitively weatherwise and unerring in their forecasts. This doubtless is due to long experience of signs and portents, which pass unnoticed by those on whose occupations the weather has neither direct influence nor effect.

Figure 3. Soft Clouds (Cumulus).

Figure 4. Fleecy Clouds (Cumulus).

Barometers, weather charts, and many ingenious and useful scientific inventions now are available as aids in forecasting, and they are of great value in dealing with wide areas, or when the object is to ascertain the general conditions of future weather some time ahead. But for restricted areas and the immediate future, forecasts may safely be trusted to the instincts of the practised observer with barometic readings only.

Storms as a rule travel over these islands to the N.E. from the direction of the Atlantic Ocean. With the nature of storms I am not concerned in this article. There are numerous scientific treatises which may be consulted by the would-be meteorological student. My purpose is to indicate to amateurs the broad lines to follow in forecasting local weather.

To begin with, a rising barometer indicates returning fair weather, a falling barometer means coming bad weather. The actual height of the readings is of little importance. The aspect of the sky, the quality of the atmosphere, and the nature and appearance of the clouds are the natural indications of weather which require close observation.

The colour of the sky at sunrise and sunset is significant: lurid, hard colours are bad omens; soft, pleasing tints are good. The sun rising in a grey horizon and setting in a clear horizon means a continuance of fine weather.

> Evening red and morning grey
> Are sure signs of a fine day.

Apart from prevailing clouds the degree of transparency in the atmosphere is important in a forecast. Most people will have been struck at times with the clearness with which distant objects stand out to view just before the setting in of a wet spell of weather. A sparkling or steely-looking atmosphere and an unusually clear, bright sky at sunrise frequently precede a wet day, while a dull, rainy early morning is as often the herald of a fine day.

"Rain before seven, fine day before eleven," is a fairly reliable saying. Much dew in summer means a moisture-laden atmosphere; hoar-frost in winter has a like significance, and is due to anticyclonic conditions which

Figure 5. Hard Clouds (Cumulus).

after two or three frosts are generally dispersed by encroaching disturbances. Electricity in the atmosphere is the cause of the peculiar tints of the close, massive clouds which frequently precede a thunderstorm. The appearance of small, hard molecules of clouds is a warning of a highly electrical state of the atmosphere.

Clouds are of two main types of marked characteristic differences. They are the Cumulus or Heap type and the Stratus or Layer type. The prevailing type of cloud depends on the conditions of the atmosphere. Cumulus predominates in disturbed conditions; Stratus prevails in equable conditions, although a steady, equable condition of atmosphere is occasionally present in bad weather. Fine, settled weather with plenty of sun is often indicated by soft clouds (as shown in Figure 3). Fleecy clouds indicate the approach of a change, perhaps to rain (see Figure 4). Hard clouds are indicative of strong winds (see Figure 6).

FIGURE 6. Stratus.

FIGURE 7. Cirrus.

FIGURE 8. Tyrell Cumulus.

In fine, steady weather, particularly in winter, the sky may be almost or completely covered by a uniform layer of low clouds (stratus), which will altogether obscure the sun: this cloud is of a generally soft appearance, showing lines on the horizon. (It is illustrated in Figure 6.) After a time this cloud gives place to another variety of stratus, a high, white, usually thin and feathery cloud, which is commonly known as "mares' tails," and is scientifically described as Cirrus. This cirrus cloud throws long threads across the sky, apparently radiating (owing to an effect of perspective) from points on the horizon (Figure 7 shows this cloud). In weather forecasting special attention should be paid to those radiating points if the cirrus cloud is present. If the radiant point appears first on the N.W. horizon and the cirrus is found to be moving from that direction over the observer a storm is approaching him from that quarter, and the following weather incidents may be looked for: the threads of the cirrus gradually coalesce; the sun or moon surrounded by a large white ring disappears as the cloud thickens; the density increases in a downward direction; rain falls; wind from the S.W. may increase to gale force and blow for several hours; then a break becomes apparent on the horizon to the N.W., the rain ceases, cumulus clouds appear, and there are occasional squalls (see Figure 8); gradually the wind hauls away to the northward, decreasing in force as it goes. In the event of such a disturbance passing to the northward of an observer the cirrus threads appear first radiating from northward of N.W. The wind in this case may not shift, and the weather may clear up gradually in a prevailing S.E. wind.

If, on the contrary, the storm should pass to the southward, the radiating cirrus points appear in a S.E. direction. When a storm has passed a heavy rainfall sets in, not infrequently without any warning. This rain is due to "secondaries," and is very difficult to forecast, as the fall of the barometer is very slight, and there are no natural indications that a continuous rain unaccompanied by wind will set in before the final clear-up.

FIGURE 9. Sun Shadows.

Unfortunately bad weather does not always adhere to the routine sketched above; the deviations are too frequent to be called exceptional, and they are the true test of the forecaster's intuitive skill.

The Meteorological Office, South Kensington, issues at a nominal cost valuable forecasts, which should be of great assistance to those in the country.

The weather bureaux of the world are at present busy with investigations of the upper atmosphere, and we may hope that their labours will result in a great increase of knowledge of the laws of storms, a matter of which we now know but little. It is more than likely that the winds are fed from the more or less permanent areas of high pressure over the oceans, and that these, too, are responsible for the eddies and eccentricities of the air-currents and storm tracks which at present so baffle meteorological students.

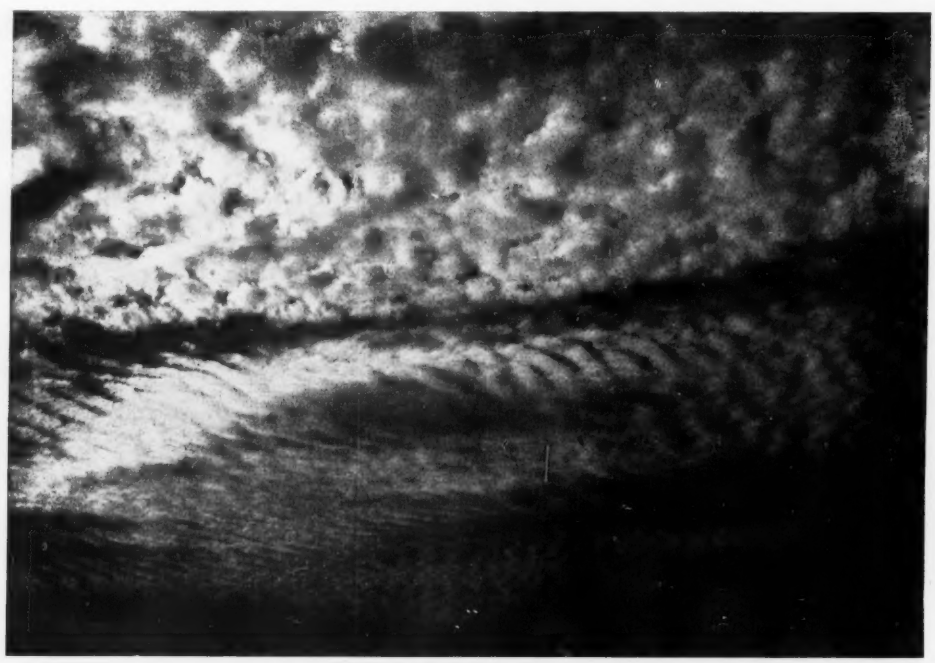

FIGURE 10. Mackerel Sky.

Fleecy clouds generally mean coming rain; two or more layers of these clouds mean wind and bad weather; the same clouds passing over the sun or moon cause rings coloured like the spectrum to appear close round these bodies; these rings are known as coronae. Cirrus clouds are essentially clouds of warning. The beautiful "mackerel" sky shown in Figure 10 is essentially a sign of approaching bad weather. Squall cumulus often gives a beautiful shadow effect by the sun shining through the rifts in the clouds (see Figure 9).

[It will be seen that the consideration of clouds forms an exceedingly interesting branch of Nature Study, and one which must of necessity have been followed from the very earliest times. Primitive man had to be able to foretell the weather, just as he had to learn the habits of animals and the properties of plants in order to live. Possibly instinct helped him to begin with, as it does birds and other animals; but later on experience, must have come from careful observations.—EDS.]

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

PROFESSOR LOWELL.—It is with much regret that I record the death of Professor Lowell, whose name has become well known throughout the world in connection with his work on Mars. Whatever view one may take about some of his conclusions, everyone must admire his devotion and perseverance in first seeking for a station where the observing conditions were the best possible, and then erecting a first-class observatory, with a very fine twenty-four-inch equatorial by Alvan Clark, supplemented later by a great reflector. He did not, like some amateurs, get weary of the work after a year or two, but persevered for upwards of twenty years, observing each portion of the planet at all stages of the Martian year. He was thus enabled to detect some of the laws of seasonal change in the markings. The first photographs of the planet that showed the canals unmistakably were taken at Flagstaff. It is now no longer possible to deny the objective reality of many of these streaks, though the photographs do not demonstrate that they are as narrow and straight as shown in some of the drawings. Very good spectroscopic work was also done at Flagstaff. The water-vapour band in the red was photographed in Mars' spectrum, and it was shown to be probably due to the Martian atmosphere, not to our own. The rotation of Uranus in ten and three-quarter hours was found, and the slow rotation of Venus rendered probable. A series of spectrograms of the four giant planets showed in a striking manner the strengthening of the great absorption bands as we proceed outwards from the Sun.

The very tedious and laborious work of photographing the spectra of some of the nebulae with continuous spectra was also successfully carried out at Flagstaff. The extremely rapid motions of these nebulae in the line of sight were detected there, also the rotatory motion of some of them. These startling results have now been verified elsewhere, and throw much new light on the status of the white nebulae.

Though the death of Professor Lowell must mean an immense loss of energy and driving power, I am glad to learn that he left funds for continuing the work of the Flagstaff Observatory.

PROFESSOR BARNARD'S PROPER-MOTION STAR.—This faint object, which I have mentioned in my Notes for August and November, is a very interesting object. It runs a very close race with Alpha Centauri for the honour of being the nearest star to the solar system. It may prove to win the race when all the observations for parallax have been published; but in any case it is the nearest star visible in our latitudes. There are four determinations of its parallax to hand. Professor Schlesinger gives $''\cdot50$; Professor Russell, $''\cdot70$; my own result from Professor Barnard's micrometer measures is $''\cdot78$; while M. Gonnessiat, from measures from three photographs taken at Algiers, gives $1''\cdot00$. There is an unexpectedly large discordance between these, which may be explained when the details are published. The mean is $''\cdot75$, practically the same as that of Alpha Centauri. The value of the parallax found from the spectrum was $''\cdot20$, evidently too small; but the extreme photographic faintness of the star put great difficulties in the way. It is of type Mb, the same as Alpha Herculis, but with the differences that distinguish a dwarf from a giant star. Many stars of this type are variable, and the Barnard star should be watched to see if its light is steady. It will form the standard model of a dwarf star, being of less than 1/3000 of the intrinsic lustre of the Sun. If we imagine its surface brilliance equal to the Sun's, its diameter would be only twice that of the Earth. It is certain that its surface brilliance is much less than that of the Sun. If one-hundredth of the brilliance, its diameter would be twice that of Jupiter, so that unless its surface has almost ceased to shine at all it must be considerably smaller than the Sun. Its visual magnitude is 9·5; its photographic magnitude 11. The difference between them is large, owing to the red colour. The Sun at the same distance would be of the first magnitude.

It is now certain that Lamont observed the star on July 24th, 1842. He made an immense catalogue of faint stars observed with a four-inch transit at Munich. He considered speed more than accuracy, and his places are liable to errors of two seconds or more. Still, even with this liability, such an early position of this interesting star is valuable. (It will be recalled that Lamont made some observations of Neptune before its discovery as a planet, which were useful in determining its orbit.)

The following table gives the different determinations of the proper motion of Barnard's star:—

Positions used.	Annual P.M.	Position Angle.
	$''$	°
Lamont, 1842; Greenwich, 1916	10·25 ...	356·34
Barnard, 1894; photo, 1916 ...	10·32 ...	356·61
Russell, 1894; photo, 1904; photo, 1916	10·38 ...	355·8
Wolf, 1898; photo, 1914 ...	10·16 ...	—
Gonnessiat, 1897, 1910, 1916; all photos	10·286 ...	356·07
Mean (epoch 1900)	10·279 ...	356·21

If we adopt the above mean values of parallax and motion, and take the speed of approach as ninety kilometres per second, the star will make its nearest approach to the Sun in nine thousand five hundred years, when the parallax will be $1''\cdot3$, and the magnitude 8, provided there is no intrinsic loss of lustre. The star will then be near ξ Draconis, not far from the pole of the ecliptic. The annual proper motion will have increased to $10''\cdot38$ in the year 2000, and the parallax will increase $''\cdot01$ in two centuries. The star's position for the epoch and equinox of 1900·0 is R.A. $17^h\ 52^m\ 56^s\cdot78$, N. Dec. $4°\ 25'\ 7''\cdot8$.

METCALF'S COMET.—The fourth cometary discovery of last year was made on November 21st by Rev. Joel Metcalf in the course of his photographic search for minor planets. It is also the fourth comet that he has discovered. It is stated to be very faint. [Further determinations of the parallax are now to hand; it is not much greater than $0''\cdot50$.]

XUM

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

THE PIGMENTS OF COPYING-INK PENCILS IN WRITING.—During the past few years the writer has had occasion to examine the pigments of copying-ink pencils in writing in connection with two criminal trials and one civil action, and has therefore made a close study of their characteristics.

They were apparently invented about the year 1874, for the first English patent bears that date. In a recent issue of the *Analyst* (1917, XLII, 1) analyses (by the writer) of twenty-one different pencil pigments are given, and from these it appears that they may be classified into four main groups, namely, (1) those composed of graphite and dyestuff only; (2) those in which the dyestuff has been incorporated with, approximately, equal proportions of kaolin clay and graphite; (3) those in which the kaolin is largely in excess; and (4) those in which the graphite predominates over the other two ingredients.

In the case of the violet pencil the dyestuff is almost always methyl violet, but in pencils of other colours mineral colours are sometimes used in addition to an aniline dye.

The copying properties vary very greatly. They depend, not only on the proportion of dyestuff, but also on the influence of the substratum, which may contain alumina, on the solution of the dye. The nature of the graphite also has an influence on the copying properties; the behaviour of the written characters on treatment with a drop of water, or, in other words, their copying properties in miniature, may thus be used as one of the tests for distinguishing between the pigments of different pencils in writing. The behaviour of the pigments with different solvents, such as ether and acetic acid, is also characteristic, whilst a further microscopical test depends on the amount of carbon remaining in the residue after extraction of the dye with a solvent. By way of illustration the case of *Rex* v. *Wood*, tried in 1907, may be cited. Some fragments of partially burned paper on which were words written in copying ink pencil, were found in the grate of a room where a woman had been murdered. Suspicion fell upon Wood, who was arrested, and in his pocket was found a Swan copying-ink pencil. The question was thus raised whether the pigment of this pencil could have been used in writing the fragments. The colour of the pencil pigment matched that of the writing in the fragments in every respect. It resembled that of some of the American pencils, but a solution test with a drop of water sharply differentiated between them. Solution tests with ether and acetic acid gave identical results, and the amounts of graphite left in the colour-free residue were exactly similar, as were also the results of tests with various chemical reagents. After denying for weeks that he had written the words on the fragments, Wood subsequently admitted that he had done so.

In another case (*Rex* v. *Seddon*) the question was raised whether the entries of payments in a note-book over a period of fourteen months had been made on the corresponding dates. The pigment of the copying-ink pencil was of the same character throughout the whole period, but it was of course impossible to express an opinion as to the age of the writing.

In the case of *Macbeth* v. *King*, which was tried last July the question of the fastness of copying-ink pencils was raised. The steamship "Membland" was presumably lost at sea in 1915. Two months later the stave of a wooden bucket was washed ashore near Hornsea, and on this was written, in copying-ink pencil, the words "Membland torpedoed engine-room, port side. Good-bye, dear." If this were genuine it would tend to show that the vessel had been sunk by war-risks, and one set of underwriters would be liable. Otherwise it was contended that the ship had fallen a victim to ordinary marine risks.

As some doubt was expressed as to the possibility of copying-ink pencil withstanding the action of salt water for two months, experiments were made by the writer to determine the point. Pieces of oak on which words had been written with four different types of copying-ink pencil were immersed in strong salt water for two months in a glass basin which was frequently shaken and exposed to light and air. In each case the writing was quite legible at the end of the period. In giving his decision the judge held that, conceivably, the stave was genuine, but he was not convinced on the point. He decided, however, upon other grounds that the vessel had been lost by war-risks (see *Times* Law Reports, 1916, XXXII, 581).

SUBLIMED SULPHUR.—In the process of subliming sulphur is heated in closed vessels and the vapours condensed in large chambers. This causes it to undergo changes in its physical characteristics, a description of which is given by M. Fonzes-Diacon in a recent issue of *Annales Falsificat.* (1916, IX, 333). As collected from the subliming chamber the sulphur is graded into products termed *grésil*, *éponges*, *grapillons*, and *candi*, according to their degree of fineness. The proportion of sulphur insoluble in carbon disulphide stands in direct relationship to the degree of fineness. For example, a sample taken from the floor of the subliming chamber contained 32·7 per cent. of insoluble sulphur, whilst another from the walls contained 30 per cent. A third sample, taken about three yards from a vapour inlet, was much coarser, and consisted of a mixture of the first three grades, whilst a fourth sample, collected at a point nearer to the inlet, was still coarser, and consisted of *éponges* containing only 0·3 per cent. of insoluble sulphur. A sample of *candi*, collected immediately above an inlet, consisted of large fused masses, which were practically free from insoluble sulphur. By sifting the sulphur through a 100-mesh sieve and determining the insoluble sulphur in the residue (*grésil*) on the sieve and in the *flowers* which passed through the mesh it was found possible to judge both as to the purity and the quality of a sample. For example, a very pure commercial sample contained 28·2 per cent. of insoluble sulphur, and by sifting was separated into coarse *flowers* with 27·3 per cent. and fine *flowers* with 29·5 per cent. of insoluble sulphur. In like manner a badly made product of poor quality yielded *grésil* (retained by a 100-mesh sieve) with 2·3 per cent., coarse *flowers* with 4·8 per cent., and fine *flowers* with 1·87 per cent. of insoluble sulphur. In every instance of pure sublimed sulphur the ratio of the insoluble sulphur in the *grésil* to that in the coarse *flowers* was less than unity. The addition of about 20 per cent. of ordinary powdered sulphur to sublimed sulphur caused this ratio to exceed unity.

GEOLOGY.

By G. W. TYRRELL, F.G.S., A.R.C.S.

THE COLOURING MATTER OF "RED BEDS."—Many speculations have been put forward to account for the origin of the colouring matter of the "Red Beds" which occur at intervals in the geological column. In the British region the most important horizons of "Red Beds" are the pre-Cambrian Torridon Sandstone of the north-west of Scotland, the Old Red Sandstone of Scotland and Wales, and the New Red Sandstone which covers large areas in Central England. The usual colouring matter is ferric oxide, in the form of haematite and limonite. A very complete study of the origin and history of the colouring matter of these rocks, with special reference to the Permo-Carboniferous and Triassic of Western America, has been made by C. W. Tomlinson (*Journal of Geology*, February-May, 1916). It has often been asserted that the red iron-stain has been introduced by meteoric waters, subsequently to the deposition of the rocks, and it is true that the colour boundaries in the Red series often follow bedding planes. Unfortunately, however, for this hypothesis, the more

brilliantly coloured rocks are usually the shales, which should be impervious to the iron-bearing solutions. Moreover, the bog-iron ores, which are known to be due to the precipitation of ferruginous solutions, are not found in the "Red Beds." The author consequently comes to the conclusion that the ferruginous matter was transported and deposited as a mechanical sediment in exactly the same way as the other clastic material; that it dates from the time of sedimentation of the beds in which it is found; and that it has now much the same distribution and arrangement as when first deposited. While red sediments are not in themselves indicators of aridity—since red soils may form, and red materials may be deposited, in regions of high rainfall—they should bulk more largely in the sediments of arid than of humid regions.

BRITISH GLASS SANDS.—One good effect of the war is to stimulate interest in raw materials of British origin, and the stoppage of supplies of Continental glass sands has led to the investigation and utilisation of British sands. This work has been undertaken by Dr. P. G. H. Boswell, whose results have been published by the Imperial College of Science and Technology on the instruction of the Ministry of Munitions ("A Memoir on British Resources of Sands suitable for Glass-making," 1916, 92 pages). In addition to its obvious purport, the memoir contains a good account of the nature, composition, and methods of investigation of sands in general. A good glass sand should have a very high silica content, and should consist of grains (mostly quartz) belonging to one grade of size, preferably not a coarse grade. The percentage of iron oxide should be very low, and the sand should be free from calcareous material. Unfortunately very few British sands are suitable for the finest kinds of glass, and these are of limited extent and uniformity; but there is abundance of material suitable for flint glass, soda glass, laboratory ware, lamp chimneys, globes, and bottles.

MICROSCOPY.

By F.R.M.S.

GAMBOGE PARTICLES IN SALT CAVITIES.—Ordinary table salt, alum, and many other transparent crystals contain cavities with liquid inclusions and mobile

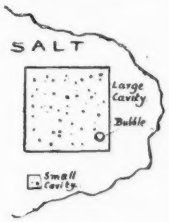

FIGURE 11.

bubbles, similar to those found in quartz, topaz, emerald, and so on. The special table salt prepared by evaporation at Maldon, in Essex, is particularly effective, as the crystals present flat flakes of considerable size, well adapted for mounting in balsam. The cavities are square, and in many of the larger ones the bubble is much too large to show Brownian movement. If a little gamboge is rubbed up in water, so as to produce a very pale yellow liquid (a strong solution must be avoided), and the salt is dissolved in this, and then recrystallised, the cavities will imprison gamboge particles. The crystals, when formed, should be washed, before mounting, in methylated spirit, to dissolve away any external gamboge particles, and may then be mounted in balsam. Nearly every cavity will be seen to swarm with moving gamboge specks, plainly visible with a quarter-inch objective, but shown to greater advantage with dark-ground illumination. The larger cavities, with bubbles too large for Brownian movement, will contain a very large number of moving gamboge particles, while in some of the small cavities as few as two or even one single gamboge particle will be enclosed. Contrary to the statements of some writers on pedesis, the movement is not arrested by the strongly saline nature of the medium on which the particles float. For a really permanent water-tight cell, perhaps these cubical salt inclusions, when suitably mounted, would be hard to beat.

CHARLES E. BENHAM.

PHOTOGRAPHY.

By EDGAR SENIOR.

A PERMANGANATE PERSULPHATE REDUCER.—Although there are quite a number of substances that can be employed to reduce the density of our negatives when required, their action generally may be classified under two headings: first, those which remove a greater percentage of the deposit from the higher densities; second, those which remove a higher percentage of the deposit from the lower densities. But a reducer that would act proportionately by removing the same proportion of all the densities, and at the same time be under complete control, and not erratic in its manner of working, has long been looked for by photographers. A reducing agent of the kind desired, which will reduce the densities of an over-developed image in such a manner that the resultant effect is that of a correctly developed negative, has been found in a mixture of potassium permanganate and ammonium persulphate, as the disadvantages which attend the use of either of these bodies when used separately disappear in the mixture, which acts in a proportionate manner. Particulars of this reducer, together with formula for use, have been published by Mr. Norman C. Deck in *The Australasian Photo Review*. In a communication, however, from the research laboratory of the Eastman Kodak Company the following formula, which is a slight modification of Mr. Deck's, was found to give the best results on all common types of emulsions:—

	A.	
Potassium permanganate	...	0·25 gramme
Water	... ...	1000 cubic centimetres
Sulphuric acid (ten-per-cent. solution)	... ...	15 cubic centimetres
	B.	
Ammonium persulphate	...	25 grammes
Water	... ...	1000 cubic centimetres

For use mix one part of A with three parts of B. The solutions will keep well separately, but should not be mixed until ready for use. Greater control over the action can be obtained by diluting the mixture with an equal quantity of water. The time occupied in reduction varies from one to three minutes, and when completed the negative should be immersed for five minutes in a one-per-cent. solution of potassium metabisulphite and then washed for a short time. Various statements having been made regarding the relative advantages of soaking the negative in water before applying the reducer as compared with its action when the film was dry, experiments went to show that there was not much difference, except that there was a tendency to loose fine detail in the shadows when the negative was used in its wet state, and with the formula given it is best to use the negative dry. With regard to hardening agents in the fixing bath employed to fix the negatives in affecting reduction, the difference shown was found to be small, although a slightly greater and more uniform reduction was obtained with negatives that had been fixed in a bath of plain "hypo." The effect of temperature was also studied, it being found that, while the amount of reduction increased rapidly with the temperature, the proportionate nature of the reduction remained unaltered. The authors of the communication also investigated the action of most of the well-known reducers, such as the ferricyanide and "hypo," ammonium persulphate, potassium permanganate, iodine and potassium cyanide, potassium bichromate, Belitski's, and so on; and it was found

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that nearly all the commonly recommended reducers, with the exception of those of the persulphate type, have a greater effect on the lower densities. Now reducers are often employed in cases of over-exposure; and, as ferricyanide and "hypo" lowers each density by the same amount, and so produces the appearance of the plate having received less exposure, as well as in most cases slightly increasing the contrast, this type of reducer is useful in correcting over-exposure where the negative is either flat or very dense. Experiments carried out with potassium permanganate, which has often been stated to act as a proportionate reducer, showed that this substance really acts in almost the same manner as ferricyanide and "hypo." It therefore appears that none of the commonly employed reducers are of use as true rectifiers in cases of over-development.

AVOIDING STRESS MARKS ON BROMIDE AND GASLIGHT PAPERS.—The well-known markings due to friction which often make their appearance on development when glossy bromide or gaslight papers are used may be avoided, according to an article published in *The Photographic Journal of America*, by the addition of "hypo" to the amidol developer. The formula for development that is recommended is as follows:—

Amidol	25 grains
Soda sulphite	300 ,,
Water	10 ounces

A few drops of ten-per-cent. potassium bromide and from six to ten grains of "hypo" are then added, and any bromide or gaslight prints developed with such a developer will be found free from any of those markings which might otherwise appear as the result of friction on the surface of the paper.

A ONE-SOLUTION PYRO DEVELOPER.—Writing in *Camera Craft*, Mr. Thomas Southwold describes the preparation of a one-solution pyro developer that will keep well, and which has been found very useful in developing batches of plates in a tank. The following is the formula recommended:—

Pyro	567 grains
Soda sulphite (desiccated)	3155 ,,
Sodium bisulphite	720 ,,
Sodium carbonate (desiccated) ...	960 ,,
Potassium iodide	5 ,,
Water to make	1 gallon

The method of preparation recommended is first to dissolve the soda sulphite in thirty-two ounces of hot water and then add the bisulphite. Bring the solution to the boiling-point and keep it at that temperature for five minutes. The solution must then be cooled to between sixty and seventy degrees Fahrenheit and the pyro added. The sodium carbonate is to be dissolved in sixteen ounces of hot water, together with the potassium iodide, and when cold the two solutions are to be mixed and made up to one gallon with water. After several batches of plates have been developed the developer would require strengthening, and for this purpose a solution made according to the following formula, and prepared in the same manner as the first one, is recommended:—

Pyro	120 grains
Sodium sulphite (desiccated) ...	630 ,,
Sodium bisulphite	150 ,,
Sodium carbonate (desiccated) ...	1490 ,,
Potassium iodide	4 ,,
Water to make	60 ounces

PHYSICS.

By E. S. GREW, M.A.

THE TEMPERATURE OF SPACE.—What is the temperature of space? It is popularly, if not generally, assumed to be that of absolute zero, and when people speak of the "cold of outer space" they think of the nadir of temperature. But M. Charles Fabry has lately pointed out that at a point in free space the notion of temperature does not have any meaning in itself. We have to imagine a small testing body to be put in the neighbourhood, and to suppose that when acted upon by the radiations traversing space this body will assume a certain equilibrium of temperature, which may be called the temperature of that point; just as when a Fahrenheit thermometer marks 72°, we assume that to be the temperature of the room. But this notion is wanting in precision, because the temperature of the testing body depends so much on its nature, its size, and the conducting properties of its surface. But having defined his theoretical testing body, and having hypothetically placed it within the radiating influence of the Sun, or of the stars, M. Fabry proceeds to determine the heat it absorbs in terms of the radiation it receives. He calculates, for example, that his standard testing body, endowed with selective absorption, could be maintained at a temperature of 750° by the Sun, which has a temperature of 6000° absolute, though the Sun were removed to a distance equivalent to fifty light-years, and appeared no more than a star of the sixth magnitude. Now suppose the Sun to disappear, or to be so far removed that it becomes any one of the stars. What will the radiation of the *ensemble* of the sidereal universe amount to? M. Fabry attempts an answer as follows. The intrinsic brightness of the night sky outside the Milky Way is equivalent to that of a star of the fifth magnitude for every square degree. That is equal to a star of magnitude equal to $-6{\cdot}5$ for the whole of the celestial sphere, or, if the brightness of the Milky Way is reckoned as well, to a star magnitude of -7 for the *ensemble* of the heavens. With these and one or two other rather uncertain assumptions we can calculate that the testing body will be brought up to about 3° absolute temperature of the radiation of the stars. Hence we may conditionally assume that 3° absolute temperature, or $-270°$ C. below zero, is the temperature of space. It is to be noted that, while no efforts of the cryogenists, Sir James Dewar or Dr. Kammerlingh Onnes, have attained a temperature of absolute zero, yet at Leyden, and probably at the Royal Institution, the solidification of helium has brought us down either close to, and perhaps below, this hypothetical temperature of outer space.

THE UBIQUITOUS ION.—In the series of lectures at the Royal Institution in which Sir J. J. Thomson compromised with the wave theory of light he described the wave front as being constituted in a series of points. The theory has since been developed that the vibrations of atoms producing light start from the decomposition of the atom and the release of its ions. In *The Physical Review* Mr. C. D. Child gives an account of some work supporting the view that light is created by the recombination of ions into atoms. The ion, the ghostly messenger, achieves a continually greater importance in physics, and, indeed, in almost every realm of physical and chemical speculation. Its ubiquity is gaily reflected in some verses addressed to it by Mr. Cloudesley Brereton in the current number of *Science Progress*, from which we quote the concluding canto of "The Song of the Ion":—

> Mountains may crumble and continents shrink,
> And Ocean's bed run dry;
> Planets be shattered, the Sun go out,
> But I—I can never die.
> At one with Matter that is flesh of my flesh,
> With Energy, soul of my soul;
> I unite with all, or slip through their mesh,
> In my quest from Pole to Pole.

Dithyrambic, but incontrovertible.

TEMPERATURE AND GRAVITATION.—Dr. Shaw recently asserted the discovery of evidence that the constant of gravity was not independent of temperature, but varied with it. Dr. Todd has offered a suggested explanation of this variation, the basis of which is that the movement of an attracted mass to or from an attracted body must be accompanied by a change of temperature. A thermodynamical

formula for the work done can be constructed and an expression found for the attracton between two masses which would contain a term that depended on the heat of the masses and their surroundings, in addition to the usual equation, which is dependent only on the masses and the distance between them.

BRIGHTNESS AND CONTRAST.—The eye, in adjusting itself to light, derives the greatest benefit in perceiving objects from contrast. The matter of contrast is of great importance in ensuring clear vision, and either excessive or deficient contrast may be equally troublesome. Vision is best in the contrasts about 1 in 20, though contrast can be perceived at such a ratio as 98 to 100. In sunlit scenes out of doors, contrasts rarely exceed 1 in 20. Indoors the contrast is seldom over 1 in 200, though window frames against a bright sky may give a contrast of 1 in 10,000. Experience suggests that the ratio be kept below 1 : 100. In full daylight, with the eye adapted to relatively great brightness, even an incandescent filament may not appear very glaring, whereas in the dark a lighted match is dazzling momentarily. In cinema theatres the illumination of the screen varies from half to one foot-candle. The ratio of 1 to 100 would imply brightness of surroundings in such a theatre equivalent to the one hundredth of a foot-candle.

RADIOGRAPHY.

By ALEXANDER FLECK, D.Sc.

PHYSICAL PROPERTIES OF ISOTOPES.—The existence of isotopes is now beyond dispute, and most scientific men accept the view that, chemically, they are non-separable. The question, however, is still in dispute whether the physical properties of two isotopes should be different. Well-known mathematical physicists, such as Böhr and Lindemann, answer this question in diametrically opposed ways. The discussion is rendered somewhat complex by the great difficulty of giving a clear and concise definition which will distinguish between chemical and physical properties. The only properties which have been experimented upon are spectra, density, and condensation. The condensation experiments may be dismissed at once as inconclusive, but there is no doubt that in the two cases which have been tried, thorium and ionium, ordinary lead, and lead from radio-active minerals, the spectra of isotopes are identical. Careful experiment failed to show any new lines, or even the displacement of a line. It has been possible to experiment only on the density of ordinary lead and on that of lead from a radio-active mineral. Atomic weight determinations show that, although chemically identical, there is an essential difference of from one to two units of atomic weight between the two. The first evidence on this point was given by Professor F. Soddy to the meeting of the British Association in Manchester fifteen months ago, and further work has been described by Richards and Wadsworth (*Journal of the American Chemical Society*, September, 1916). The density of ordinary lead they found to be 11·337, while that of lead derived from picked crystals of clevite was 11·273. In the two cases the atomic weights were 207·20 and 206·08 respectively, and if we divide the atomic weights by their respective densities we get the atomic volume. For these elements this value works out to be 18·281 and 18·277. It is therefore to be concluded that the atomic volumes of a set of isotopic elements are equal.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

SHAKESPEARE AND BIOLOGICAL SCIENCE.—In a very interesting essay Professor D. Fraser Harris, of the Physiology Department in the University of Halifax, Nova Scotia, examines some of Shakespeare's references to biological facts. "The nimble spirits in the arteries" ("Love's Labour Lost") is a direct echo of Aristotelian Galenical teaching. The words in "King John," "blood . . . runs tickling up and down the veins," express the pre-Harveian notion of a to-and-from blood-tide. Shakespeare died before the discovery of the circulation of the blood was announced, but there is a well-known passage in "Coriolanus" which states the idea of the abdominal viscera receiving food and working it up into blood, to be distributed to all the parts of the body. Perhaps Professor Fraser Harris reads too much into the saying in "Richard II" "things sweet to taste prove in digestion sour"—when he refers to the fact that sugars, in being digested, pass through a stage of lactic acid. Very remarkable are the learned words of the schoolmaster Holofernes in "Love's Labour Lost," which describe ideas as "begot in the ventricle of memory, nourished in the womb of pia mater, and delivered upon the mellowing of occasion." Very striking is the prevision which led Shakespeare to say in "Hamlet," "Sense, sure, you have, else you could not have motion." For sensory tracts in the central nervous system develop before those which subserve movement. The reference to the glow-worm's "uneffectual fire," in the same play, is very curious, for it is a modern discovery that the light of the glow-worm is unaccompanied by heat.

INSTINCT OF THE PACK.—In his important book, "Instinct of the Herd" (1916), Mr. W. Trotter has a fine passage on the advantages that gregariousness has secured for wolves. "The wolf pack forms an organism, it is interesting to note, stronger than the lion or the tiger; capable of compensating for the loss of members; inexhaustible in pursuit, and therefore capable by sheer strength of hunting down without wile or artifice the fleetest animals; capable, finally, of consuming all the food it kills, and thus possessing another considerable advantage over the large solitary Carnivora in not tending uselessly to exhaust its food supply. The advantages of the social habit in Carnivora are well shown by the survival of wolves in civilised countries even to-day." Kipling's "Jungle Books" are of course preëminent in their appreciation of the instinct of gregariousness.

BIRDS AND NAUSEOUS INSECTS.—Experiments made by Mr. C. F. M. Swynnerton on the appetite of woodhoopoes, small hornbills, and a babbler show that the most nauseous Lepidoptera, with warning coloration, may be eaten in small numbers, with apparent impunity and eagerness, by birds with empty stomachs. As the stomach fills up, fastidiousness grows. There is a progressive rejection of low-grade food. Mr. Swynnerton gives reasons for believing that the capacity of discriminating between palatable and nauseous forms is not instinctive, but acquired by experience.

BEHAVIOUR OF YOUNG CUCKOO.—In a very interesting paper in *The Zoölogist* Mr. E. P. Butterfield describes the method in which the young cuckoo ejects the nestling pipit. "The young cuckoo instinctively works its way to the bottom of the nest, where it evinces great restlessness until one of the nestlings rests its head on its back. This induces the cuckoo to lower its body, and by degrees it is enabled to get the nestling into the hollow of its back; then it commences to walk backwards up the side of the nest, keeping its victim in position by its wings, which it uses with remarkable facility, until it reaches the top of the nest, when, by an extraordinary effort, it throws its victim from its back, after which operation it remains flapping its wings for several seconds, as if to make assurance doubly sure that the process of ejectment has been successful, and then lowers itself and plunges itself into the nest." Attention is called to the tenseness of the young cuckoo's frame, to the lividness of the head during the process, and to the irritability of the back before the hollow disappears. In one of the cases observed by Mr. Butterfield two young cuckoos in one nest tried to hoist one another out, and ended in both succeeding!

XUM

THE FACE OF THE SKY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

I have decided to make this article of a less tabular form than formerly. I refer those who desire complete ephemerides to *The Nautical Almanac* (the abridged edition for sailors, price One Shilling), or *The Companion to the Observatory* (issued annually by Taylor & Francis, price One Shilling and Sixpence). Many other almanacs give a considerable amount of astronomical information.

THE SUN.—Its declination and midday altitude are now rapidly diminishing, but this is not wholly a disadvantage, owing to the lessened heat and glare. Sun-spot activity is now considerable, and the disc is seldom free from spots. An enormous spot-group (the third largest ever photographed at Greenwich) was on the central meridian on February 9th, and returned, though much diminished, four weeks later. It was not accompanied by aurorae or magnetic disturbances. The annular eclipse of December 14th is interesting from the fact that the central line passes through the South Pole. Partial eclipse, with a low Sun, is visible in the south-east of South America and in West Australia.

THE MOON is full on September 1st and 30th, October 30th, November 28th, and December 28th (on this day a total lunar eclipse, beginning visible in Ireland just before sunrise, whole eclipse visible in America). New Moon September 16th, October 16th, November 14th, and December 14th. In the autumn the waning Moon is better placed for observation than the waxing one. There are numerous occultations visible at Greenwich, but the stars are mostly faint. μ Geminorum (magnitude 3·2) will reäppear, under favourable conditions, on November 30th, 8h. 53m. p.m.

When the sky is very clear it is interesting to scrutinise the earth-lit portion; observations of the regions where Professor W. H. Pickering suspects the presence of snow or hoar-frost would be useful, as these deposits should have their maximum extent during the lunar night.

MERCURY is well placed as a morning star early in October. VENUS is an evening star, but being south of the Sun till December is not very well placed for northern observers. It is in elongation, 47° east of Sun, on November 30th, when its disc is half illuminated. MARS may be seen as a morning star towards the end of the year, but its disc is still small. JUPITER is in opposition on November 29th. It is stationary on September 30th, 4° north of Aldebaran on November 6th. This is a very favourable opposition owing to the high north declination. SATURN is visible as a morning star at the end of the year in Cancer. The ring is closing; the minor axis is about a quarter of the major one. Saturn has passed conjunction with Neptune, which is some 7° west of it in December. Commander Ainslie made the interesting observation of the occultation of a seventh-magnitude star by Saturn's ring on February 9th. The star was easily seen through the Cassini division, and faintly visible through the outer ring, brightening for a few seconds as it passed the Encke division, and another one near the outer edge. This transparency is an additional proof, if such were needed, that the rings consist of swarms of tiny bodies, each revolving independently round the planet. URANUS is an evening star, being some 3° west of δ Capricorni in October.

TABLE I.

	Mellish.	Schaumasse.	Wolf.
Perihelion ...	1917, April, 10·6746	1917, May, 18·2081	1917, June, 16·5373
ω ...	121° 18′ 7″	119° 9′ 35″	120° 36′ 1″
Ω ...	87° 31′ 49″	9° 40′ 53″	183° 17′ 50″
i ...	32° 40′ 56″	158° 43′ 42″	25° 40′ 11″
Log. q ...	9·27917	9·88318	0·22707
Period ...	142 years	Parabolic	Parabolic

The perihelion passages are in Greenwich Mean Time (day beginning at noon).

COMETS.—Two new comets, both interesting, were discovered in the spring. That of Mellish was very bright in mid-April, but was only visible then in the Southern Hemisphere. It has a curved tail 20° long. Schaumasse's Comet was interesting from its rapid apparent motion, which for some days fell little short of that of the Moon. This was owing to its retrograde orbit and small distance from the Earth. Wolf's Comet failed to correspond with the expectations that were formed of it, but it was a fairly easy telescopic object during the summer.

The orbits of the three comets are given in Table I.

METEORS.—Observers who determine the paths of meteors should work in combination with others at different stations, as the real paths of the meteors can then be deduced. In addition to their astronomical interest, meteors can give us information about our upper air, both by the height at which they become visible and by the behaviour of the luminous train that sometimes remains visible for some minutes after they burst. The position of this train with reference to the stars should be noted at short intervals, as it sometimes gives valuable information as to the direction and speed of upper air-currents.

AURORAS.—These may be looked for now, as they are more frequent at sun-spot maxima. Though phenomena of our own atmosphere, they are of astronomical significance and deserve careful record.

STARS.—A table may be useful giving the hours at which the various zodiacal constellations are due south in the

different months of the year. As the constellations differ considerably in size, the table is only approximate It applies to the beginning of the months.

Constellation.	Noon.	8 a.m.	4 a.m.	Midn.	8 p.m.	4 p.m.
Aries ...	May	July	Sept.	Nov.	Jan.	Mar.
Taurus ...	June	Aug.	Oct.	Dec.	Feb.	April
Gemini ...	July	Sept.	Nov.	Jan.	Mar.	May
Cancer ...	Aug.	Oct.	Dec.	Feb.	April	June
Leo	Sept	Nov.	Jan.	Mar.	May	July
Virgo ...	Oct.	Dec.	Feb.	April	June	Aug.
Libra ...	Nov.	Jan.	Mar.	May	July	Sept.
Scorpio ...	Dec.	Feb.	April	June	Aug.	Oct.
Sagittarius	Jan.	Mar.	May	July	Sept.	Nov.
Capricornus	Feb.	April	June	Aug.	Oct.	Dec.
Aquarius ...	Mar.	May	July	Sept.	Nov.	Jan.
Pisces ...	April	June	Aug.	Oct.	Dec.	Feb.

THE PERIODICITY OF COMETS.—A query appeared in "KNOWLEDGE" for 1916, November, page 231, relating to Hooke and a passage in "Pepys's Diary." It is a singular coincidence that a query inspired by the same passage in the "Diary" was sent to *The Journal of the British Astronomical Association*, at practically the same time, from Mr. C. Pijper, Transvaal. I quote his letter, together with the reply that I gave in *The Journal*.

The title of Mr. Brooks's query, as printed in "KNOWLEDGE," "The Periodicity of the City of Comets," affords an interesting example of the error known as "dittography," which is well known in ancient manuscripts, when words, or portions of words, are erroneously given in duplicate.

PREDICTION OF A COMET'S RETURN.

"As far as I know, and can find in the few books at my disposal here, it is always Halley that is mentioned as having first predicted the return of a Comet. Therefore I beg to draw attention to the following entry in 'Pepys's Diary':—

"'March 1st, 1664–65.—To Gresham College, where Mr. Hooke read a second very curious lecture about the late Comet, among other things, proving very probably that this is the very same Comet that appeared before in the year 1618, and that in such a time probably it will appear again, which is a very new opinion; but all will be in print.'"

C. PIJPER.

Lijdenburg, Transvaal.
September 12th, 1916.

TABLE 2.—EPHEMERIS OF WOLF'S COMET.

Date.	R.A.	Decl.	Log. r.	Log. Δ.
	h. m. s.	° ′		
Aug. 21 ...	23 39 34	16 20 N.	0·2775	9·9950
,, 25 ...	23 40 15	14 49	0·2830	9·9956
,, 29 ...	23 40 34	13 13	0·2886	9·9980
Sept. 2 ...	23 40 36	11 32	0·2944	0·0018
,, 6 ...	23 40 26	9 50	0·3003	0·0073
,, 10 ...	23 40 7	8 8	0·3062	0·0144
,, 14 ...	23 39 29	6 27	0·3123	0·0234
,, 18 ...	23 39 4	4 46	0·3184	0·0338
,, 22 ...	23 38 41	3 10	0·3246	0·0457
,, 26 ...	23 38 24	1 38	0·3308	0·0590
,, 30 ...	23 38 15	0 12 N.	0·3370	0·0735
Oct. 4 ...	23 38 17	1 8 S.	0·3432	0·0891
,, 8 ...	23 38 31	2 21	0·3495	0·1055
,, 12 ...	23 38 58	3 27	0·3558	0·1227
,, 16 ...	23 39 41	4 26	0·3621	0·1404
,, 20 ...	23 40 38	5 18	0·3684	0·1586
,, 24 ...	23 41 51	6 3	0·3746	0·1770
,, 28 ...	23 43 20	6 42	0·3808	0·1956
Nov. 1 ...	23 45 3	7 14	0·3870	0·2142
,, 5 ...	23 47 1	7 41	0·3931	0·2327
,, 9 ...	23 49 13	8 2	0·3991	0·2512
,, 13 ...	23 51 38	8 19	0·4052	0·2694
,, 17 ...	23 54 16	8 31	0·4112	0·2874
,, 21 ...	23 57 5	8 38	0·4172	0·3052
,, 25 ...	0 0 6	8 42	0·4232	0·3226
,, 29 ...	0 3 17	8 43	0·4291	0·3397
Dec. 3 ...	0 6 37	8 40	0·4349	0·3564
,, 7 ...	0 10 6	8 35	0·4406	0·3727
,, 11 ...	0 13 43	8 27	0·4463	0·3887
,, 15 ...	0 17 28	8 16	0·4520	0·4042
,, 19 ...	0 21 19	8 4	0·4576	0·4193
,, 23 ...	0 25 17	7 50	0·4632	0·4340
,, 27 ...	0 29 20	7 35	0·4687	0·4483
,, 31 ...	0 33 29	7 18 S.	0·4742	0·4622

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Halley's title to fame is not that he first suggested the possibility of comets returning—this had been done in the first century by Seneca. Hooke's announcement was merely a guess, and an erroneous one; the two comets were not really identical. It was not possible to deduce the orbit of a comet till the law of gravitation was known, with its corollary that bodies move about the Sun in conic sections. Halley applied these new principles in his cometary researches, and his conclusion that three comets on his list were the same body was not a mere guess, but a correct deduction from the facts, and it was afterwards verified by the comet's return at the time predicted.

REVIEWS.

GEOLOGY.

A Memoir on British Resources of Sands suitable for Glass-making.—By P. G. H. BOSWELL, D.Sc., F.G.S.

(Longmans, Green & Co. Price 1/6.)

In this book, which is published at the instruction of the Ministry for Munitions of War, the author gives a concise summary of the condition of our supplies of glass sands and the requirements of the manufacturers which these sands should meet. All the known British deposits and the most important foreign sands are described and their relative merits for different purposes are compared and contrasted. Chemical, mineral, and mechanical analyses are given, and the methods of performing the last two are fully explained. Mineral analyses are useful as giving a rough indication of the elements present, and showing the presence of deleterious minerals, such as zircon, which by their infusibility tend to produce flaws in the glass. The results of the mechanical analyses are expressed by a graphic method which enables the composition of the sand to be seen at a glance. The ideal glass sand is one containing 100 per cent. of silica, in angular grains of the same size, and of the grade known as medium or fine sand, *i.e.*, between 0·5 and 0·1 mm. in diameter. Alumina and magnesia may be present, but as they are only required for certain kinds of glass they are better added to the "batch" at the factory. The iron content for the best optical glass must not exceed 0·08 per cent. of ferric oxide, and in no case must it be more than 1 per cent., except in sands used for the commonest bottle glass. The sands which most nearly approach to these ideal requirements are those from Fontainebleau in France and Lippe in Germany, but the best sands from Aylesbury and Lynn are very nearly as good. Apart from the two last named sands, there are none in Britain capable of being used for the best work; but there are large resources of sand suitable for medium quality glass, such as the drift sands of Shirdley Hill in Lancashire, which have long been used for window glass. The author finally gives a general summary of the economic conditions of the supply of sands, and attributes the poor exploitation of British resources to the fact that the Fontainebleau sand and Dutch and Belgian sands can be exported to this country as ballast in returning colliers at a much lower cost than that at which the British sands can be conveyed from the pits by rail or canal.

W. H. W.

PHYSIOLOGY.

Handbook of Physiology.—By W. D. HALLIBURTON, M.D., F.R.S. Thirteenth Edition (being the twenty-sixth edition of *Kirkes' Physiology*). 930 pages. With nearly 600 illustrations and 3 coloured plates. $8\frac{3}{4}$-in. × $6\frac{1}{2}$-in.

(John Murray. Price 16/- net.)

We welcome yet another edition of this excellent handbook, which has now been brought thoroughly up to date, and a certain amount of new matter added, especially in the sections dealing with Respiration, Reproduction, and the Central Nervous System. Another new feature is the adoption of the new system of nomenclature formulated by the Congress of Anatomists which met at Basle a few years since. Where these names differ from those in general use in this country they have been inserted in brackets after the old names. The book is well printed on good paper, and there is a copious index.

We are still of the opinion that this volume is the best general textbook of Physiology in the English language.

S. H.

NOTICES.

MR. MURRAY'S QUARTERLY LIST.—We have received Mr. Murray's Quarterly List, dated July, 1917, and commend it to the notice of our readers.

WILLIAM SMITH AND HIS GEOLOGICAL MAPS.—In *The Proceedings of the Yorkshire Geological Society* for 1917 Mr. T. Sheppard has published a most interesting and valuable summary of the work of the Father of English Geology. This is specially appropriate, since Smith spent a considerable part of his life in Yorkshire, and some of his most important work was done in that county. When his work is considered as a whole, as is done in this memoir, its scope and variety are at once apparent. William Smith's maps must be regarded as the groundwork on which was raised the whole superstructure of stratigraphical geology by the labours of Lyell, De la Beche, Sedgwick, Murchison, and their successors. The names applied by Smith, often taken from obscure villages, like Kelloways, or dialect words, like "Gault," have now become known throughout the world, although in most countries ill-judged attempts have been made to supplant them by other names of almost equally parochial origin, and generally of much more uncouth form. It is interesting to find that the earliest known geological map in the strict sense of the word is one of the country round Bath, constructed by Smith in 1799, the basis of this being a plan taken from a local guide-book. This now hangs in the library of the Geological Society of London. This pioneer effort was soon followed by many others of a more ambitious kind. His first general map was published in 1815, and at Smith's death, in 1839, it may be said that the geological map of England and Wales had already reached nearly its present form, requiring only very small alterations in detail, along with some further subdivision of the older formations, below the Devonian and Old Red Sandstone.

Before his time all the attempts at geological mapping had been made on an almost purely lithological basis. In this connection special mention must be made of the soil maps of counties issued by the old Board of Agriculture under Sir John Sinclair, which undoubtedly were of much help to Smith in his work. Now that the importance of soil-surveys is at last beginning to be recognised in this country, perhaps they may receive some of the recognition which they really deserve.

William Smith was also, as is well known, the first to establish clearly the importance of fossils as time-indices, and by a happy combination of rock-characters and fossil-contents he worked out in most remarkable detail the geological structure of England, thus laying the foundations of the science which enabled his successors to unravel the complicated history of the world.

The Yorkshire Geological Society and Mr. Sheppard are to be heartily congratulated on their enterprise in bringing out a work which must have necessitated an immense amount of labour, patience, and research. It is profusely illustrated with diagrams and reproductions of maps, manuscripts, title pages, and portraits.

R. H. RASTALL.

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